CLAIMS

What is claimed is:

1. A method of manipulating a solid, which comprises:
measuring a first mechanical resonant frequency of a transfer device;
adhering one or more particles of the solid to the transfer device; and
measuring a second resonant frequency of the transfer device.

2. The method of claim 1, further comprising determining the mass of the one or more particles by comparing the first and second resonant frequencies.

3. The method of claim 1, further comprising depositing the one or more particles at a target location.

4. The method of claim 1, further comprising an array of multiple transfer devices to increase throughput.

5. The method of claim 2, further comprising continuously measuring the resonant frequency of the transfer device to provide a feedback cycle for manipulating one or more particles of a solid.

6. The method of claim 2 wherein the mass of the plurality of particles is less than about 1 mg.

7. The method of claim 5 wherein the mass of the plurality of particles is less than about 500 micrograms.

8. The method of claim 6 wherein the mass of the plurality of particles is less than about 100 micrograms.

9. A system for manipulating a solid, which comprises:
a transfer device comprising a means of creating an electric field or gradient that is sufficient to adhere one or more particles of a solid to the transfer device;
a means of determining a mechanical resonant frequency of the transfer device operatively coupled to the transfer device; and
a means of depositing the one or more particles.

10. The system of claim 9, wherein the means of creating an electric field or gradient comprises two or more electrodes coupled to an electrical source.

11. The system of claim 10, wherein the electrodes are concentric, parallel, planar, or interdigitated.

12. The system of claim 9, wherein the magnitude of the electric field is from about 10^5 V/m to about 10^8 V/m.

13. The method of claim 12, wherein the magnitude of the electric field is from about 10^6 V/m to about 10^7 V/m.

14. The method of claim 13, wherein the magnitude of the electric field is from about 2 $\times 10^6$ V/m to about 5 $\times 10^6$ V/m.

15. The system of claim 9, wherein the one or more particles are deposited by removing the electric field.

16. The method of claim 15, wherein the deposit of the particles is facilitated by the application of mechanical force to the transfer device.

17. The method of claim 16, wherein the mechanical force is vibration or an abrupt jolt.

18. A system for manipulating a solid, which comprises:

a transfer device comprising of a mechanical device to adhere one or more particles of solid to the transfer device;

a means of determining a mechanical resonant frequency of the transfer device operatively coupled to the transfer device; and

a means of depositing the one or more particles.

19. The systems of claims 9 or 18, wherein the means of determining a mechanical resonant frequency of the transfer device comprises an excitation signal generator and a means of detecting the effect of an excitation signal on the transfer device.

20. The system of claim 19, wherein the excitation signal generator is a piezoelectric transducer, a solenoid shaker, an acoustic speaker, or an electrostatic comb.

21. The system of claim 19, wherein the means of detecting the effect of an excitation signal is a laser displacement sensor, capacitance sensor, accelerometer, phase Doppler velocimeter, piezoelectric sensor, strain gauge, or impedance analyzer.

22. A method of manipulating a solid, which comprises:

measuring a first mechanical resonant frequency of a tube;

inserting the hollow tube into a bed powder to obtain a plug of powder;

removing the tube from the bed of powder; and

measuring a second resonant frequency of the tube.

23. The method of claim 22 wherein the tube has an interior that accommodates a means of ejecting materials from within it.

24. The method of claim 23 wherein the means of ejecting materials is a piston, vibration, pressurized gas, or a liquid.

25. The method of claim 23 wherein the plug is ejected from the tube after the second resonance frequency is measured.

26. A system for manipulating a solid, which comprises:

a tube having an interior that accommodates a means of ejecting materials from within it; and

a means of determining a mechanical resonant frequency of the tube operatively coupled to the tube.

27. The systems of claim 26, wherein the means of determining a mechanical resonant frequency of the tube comprises an excitation signal generator and a means of detecting the effect of an excitation signal on the tube.

28. The method of claim 27, wherein the excitation signal generator is a piezoelectric transducer, a solenoid shaker, an acoustic speaker, or an electrostatic comb.

29. The method of claim 27, wherein the means of detecting the effect of an excitation signal is a laser displacement sensor, capacitance sensor, accelerometer, phase Doppler velocimeter, piezoelectric sensor, strain gauge, or impedance analyzer.

30. A method of measuring the mass of a solid, which comprises:

(a) measuring a first mechanical resonant frequency of a tool;

(b) affixing a solid to the tool; and

(c) measuring a second mechanical resonant frequency of the tool.

31. The method of claim 30, wherein the tool is a coring tube or an electrode.